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Progress Report 162

C.2

1963

Oil and Gas Developments in the Youngsville-Sugar Grove Field of Warren County, Pennsylvania

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF INTERNAL AFFAIRS
Genevieve Blatt, Secretary
TOPOGRAPHIC AND GEOLOGIC SURVEY
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OIL AND GAS DEVELOPMENTS IN THE YOUNGSVILLE-SUGAR GROVE FIELD OF WARREN COUNTY, PENNSYLVANIA

By

Wilbur H. Seifert[1] and William S. Lytle[2]

INTRODUCTION

In 1948 Wilbur H. Seifert of the Pennsylvania Geological Survey staff wrote a report concerning the shallow sand developments in the Sugar Grove-Youngsville Area of Warren County. The report was never published. In August of 1962 a well was drilled in this area to the Glade sand (the producing zone) and fractured. This method of completion (by fracturing) proved very profitable and the well started flowing at the rate of 104 bbls. of crude oil per day. A well with such a high initial production in an area of historically low initial production caused considerable interest. Because of these developments it was decided to bring Seifert's report up to date and publish it.

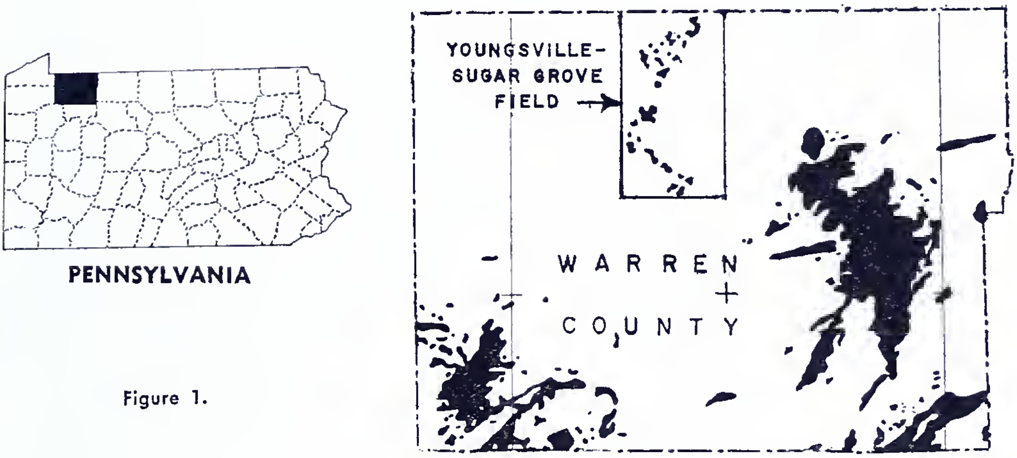

Figure 1.

The Youngsville-Sugar Grove Field, discussed in this report, is located in the eastern one-half of the Youngsville quadrangle from the Latitude of Youngsville (41° 50′ N. Lat.) northward to the state line (Figures 1 and 2). The field comprises parts of Brokenstraw, Conewango, Farmington and Sugar Grove townships of Warren County, Pennsylvania.

A considerable amount of data was obtained in 1944 and additional information was compiled in 1948 and 1962.

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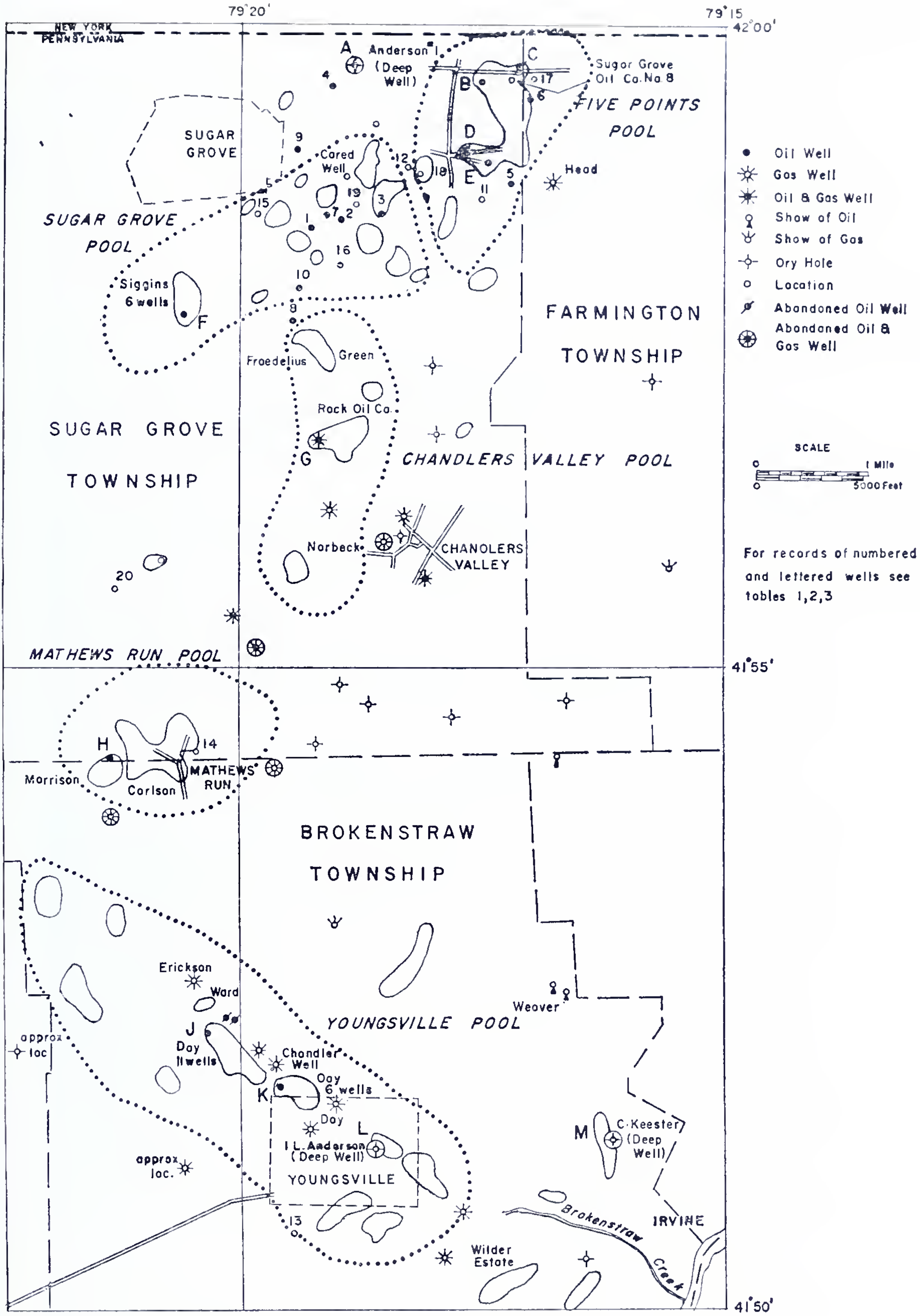
ACKNOWLEDGMENTS

The writers acknowledge the cooperation, in the preparation of this report, of Howard Curtis and William C. Stewart, operators in the area. Virginia Fairall of the Pennsylvania Bureau of Topographic and Geologic Survey did the drafting.

HISTORY OF DEVELOPMENT

Drilling for oil was carried on as early as 1865 along Brokenstraw Creek west of Youngsville. A few of these early wells were probably drilled within the area of this report. Carll (1883) states that a well drilled near Youngsville in 1881 "having been torpedoed and manipulated in the most approved manner, it produced a small quantity of oil." All other exploratory drilling in the area up to 1881 had met with no success. Sporadic drilling occurred from 1865 to 1910 after which time a considerable number of wells were drilled until, in 1915, activity tapered off. The Glade Sand is the producing sand in the area. The wells drilled during the 1910-1915 period of development were drilled at Youngsville, Mathews Run (4½ miles north of Youngsville), and in the Five Points area (2 miles east of Sugar Grove). The drilling activity in the Five Points Pool continued into the early 1920s. The Sugar Grove Gas Pool was drilled in 1925 and 1926. Subsequently, almost all the wells were either abandoned or became inoperative in the late 1920s except the wells in the Youngsville Pool and the Sugar Grove Gas Pool. Drilling was resumed in the Youngsville and Five Points Pools about 1929. In both of these pools a pilot repressuring project was attempted, but it met with no success and the projects were abandoned. However, drilling continued in the Five Points Pool with one or two drilling rigs working until 1946. Drilling activity was vigorously renewed in 1946 and about 30 wells were drilled during the year in the Sugar Grove, Five Points, and Chandlers Valley pools. Approximately 65 wells were completed in 1947 in the Youngsville-Sugar Grove Field. A pilot repressuring project was tried in the Sugar Grove Pool by Kapp, Kahle, and Curtis in 1947. Gas was injected into two intake wells the casing of which had been cemented. Pressures of 300 to 400 psi were applied to the open hole below the casing seats for 18 months without success. The project was abandoned. From 1947 to 1962 operators drilled several wells each year in the Youngsville-Sugar Grove Field.

During the fall of 1961 a 4-inch-diameter diamond air-rotary core was taken from the Sanden #14 well owned by Howard Curtis & Son in the Sugar Grove Pool (Figure 2). Coring began at 700 feet and continued to 778 feet with a core recovery of 99.9 percent. About 50 feet of Glade sand was cored of which 33 feet (from 709 feet to 742



For records of numbered and lettered wells see tables 1,2,3

General Oil and Gas Map of Youngsville-Sugar Grove Field
Youngsville Quadrangle, Warren County, Pennsylvania

Figure 2

feet) was the pay section. The Petroleum Research Laboratory, U.S. Bureau of Mines, Morgantown, W. Va., (1962) cored the well, obtained mechanical logs, and analyzed the core. The average core analyses are shown below:

Air permeability (md.)	0.3
Porosity (percent pore volume)	7.4
Saturation (percent pore volume):	
Oil	27.2
Water	31.3
Gas	41.4
Oil content (barrels per acre-foot)	214
Salinity (equivalent NaCl ppm)	98,000

Clay-staining tests on 16 samples indicate that the clay mineral kaolinite predominates, and 5 samples showed traces of montmorillanite.

Core analyses taken elsewhere in the area generally supports an estimate of 200 barrels of oil per acre-foot, or 7,000 barrels of oil per acre. These analyses also report very low permeability and a porosity range of 7 to 11 percent.

From the information gained by the core report of Sanden #14 the U.S. Bureau of Mines recommended that fracturing should be tried in order to increase oil recovery and therefore obtain an increased margin of profit.

PRODUCING SAND

The producing sand in the Youngsville-Sugar Grove Field correlates with the Glade Sand of the Warren district and is the stratigraphic equivalent of the Queen Sand of the Tidioute quadrangle. The Glade Sand in the area of this report is at an elevation of 525 to 870 feet above sealevel. The well depths range from 700 to 1200 feet, depending on the topography.

In the Sugar Grove area the Glade sand is a fine to very fine-grained, light- to medium-gray, somewhat micaceous, and generally hard sandstone. It is often slightly calcareous. The sand is about 24 to 40 feet thick with random interbedded layers of shale. Up to 5 shale beds 1 to 4 feet thick may occur. A fossiliferous, calcareous siltstone (cap-rock) is usually found at the top of the sand. The best gas pay is found from 2 to 6 feet below the top of the sand while the best oil pay is in the lower part. The Glade Sand contains saltwater throughout its entire pay section.

In areas to the south of Sugar Grove the sand may be white and pebbly. Locally it splits into two lenses. The available drillers' logs (Table 1) give meager data. Some drillers report a "white sand" in the lower part of the sand body. Others place this stratum in the

Table 1. *Records of Wells Drilled Prior to 1949 in Youngsville-Sugar Grove Field*

Map Key	WELL	OPERATOR	ELEVATION	CONDUCTOR OR DRIVE PIPE	CASING	GLADE SAND	TOTAL DEPTH	REMARKS
A	Anderson #1	T. M. Pettigrew, et al	1352′	—	—	496′-572′	*	* (deep well)
B	Larsen (Knight #1)	Sugar Grove Oil Co.	1500′	8½′	156′	646′-685′	—	
C	Lehman Trask #3)	Christ Lehman	1490′	—	—	621′——	—	
D	John Allinson #15	Howart Curtis	1569′	12′	145′	723′-753′	757′	
E	Stearns #2	Stearns Est.	1562′	21′	149′	727′-756′	756′	shot 740′-756′
F	Siggins #3	David N. Siggins	1586′	9′	177′	788′-818′	—	not shot 2500 c.f. gas
G	Swanson	Rock Oil Co.	1535′	96′	—	(820′-830′) ?	—	Memory record
H	Bowers #1	Geo. C. Morrison & Son	1627′	18′	300′	980′-1016½′	1016½′	TD still in sand shot 1000′-1016½′ with 16 qt pumped 6 bbl 16 hrs after shot
J	E. B. Day	E. B. Day	1508′	12′	265′	960′-989′	—	W of Route 27
K	E. B. Day #1	E. B. Day	1231′	7½′	163′	682′-703′	704′	E of Route 27
L	Youngsville Deep well	Star Oil Co.	1204′	63′	420′	669′-679′	*	* (Deep well) reports a "stray" sand at 663′

lower portion of the bottom lens when the sand splits into an upper and lower lens. Where the sand splits the upper lens is generally void of oil or gas. The top of the pay varies from five feet below the top of the sand to the middle of the sand body.

The white sand is generally the pay section. Gas is sometimes obtained above the oil in the upper part of the sand while saltwater is frequently obtained in the bottom of the sand. In some instances the wells are completed while still in the sand to avoid saltwater. The reported sand thickness ranges from 20 to 40 feet.

FIELD OPERATIONS

Depending on the location of the well, from 20 to 200 feet of drive pipe are used. An 8-inch hole is drilled to the casing point, a point below which fresh water is no longer encountered, varying from 180 to 250 feet below the surface, and 6¼-inch casing run. A 6¼-inch hole is then drilled to total depth which generally includes a 25-foot pocket below the sand. If saltwater is encountered in the upper part of the Eighty Foot Sand (an 80-foot zone, the bottom half being the Glade Sand), the saltwater is excluded with pipe and a set of packers. The wells are completed with 2-inch tubing and rods and pumped by central power. In some instances the wells have been bailed when not tubed while some wells have been pumped by means of a portable jack arrangement attached to a tractor. Recently some of the new wells have been pumped by individual electric jacks. The wells very seldom have to be pulled for cup replacement but holes in tubing occur every 10 to 12 years.

Ever since the drilling of the first well in the area until the beginning of 1962 the wells were always shot with nitroglycerine. The largest charge recorded was 5.79 quarts per foot. The average charge used has been about 3.5 quarts per foot. In August of 1962 fracturing was first tried in the area and it met with excellent results. At the writing of this report 9 wells have been fractured. The average fracturing job consists of about 400 bbls. of water, 10,000 lbs. of 20/40 sand, 17,000 lbs. of 10/20 sand, a breakdown pressure of 3800 psi, a treating pressure of 1300 psi with an injection rate of 25 to 40 bbls. per minute. Some operators have gone to higher fluid volumes (Table 2).

Average development costs, including those of fracturing, vary from $7500 to $10,000. So far the operators have been running 4½-inch pipe to bottom, perforating, and then fracturing through the perforations. In the Glade Sand in the Warren area east of the Youngsville-Sugar Grove Field the operators have been fracturing through open hole and in a number of cases the fracturing fluid is crude oil instead of water.

PRODUCTION

Wells which have been shot have initial productions up to 35 bbls. of crude oil the first day, 20 bbls. the second day, 10 bbls. the third day, resulting in an average of 3 bbls. a day for the first 90 days at which time the production is about ½ bbl. per day (Figure 3). At the end of two years the wells have reached an average settled production of about 1 bbl. a week and they maintain this production for a long time. In cleaning out after heavy shots considerable oil is frequently recovered prior to tubing the well. After the wells have delivered the bulk of their initial head, they require only weekly pumping since the formation pressure drives the oil into the well pocket.

Wells which have been fracture-treated have initial productions up to 185 bbls. of crude oil per day. A production curve of such a well is shown in Figure 3. At the end of 7 or 8 weeks the production levels off at a much higher rate than a well which has been shot. A number of the fractured wells have paid for themselves in 9 to 20 weeks.

Old abandoned wells have been observed to flow oil over the top of the casing in a slow trickle indicating that the reservoir pressure has not appreciably declined over a long period of time although the well had been abandoned as unprofitable.

The oil is 41° API gravity (Table 4) and is being trucked out since there are no pipeline facilities for the district.

The initial gas production rarely exceeds 30 Mcf per day. The wells decline to 500 cubic feet per day after several months and continue producing this amount for a long time. Wells with initial volumes as low as 1 Mcf in the small gas pool located about 1 mile south of Sugar Grove have been kept as producers. Rock pressures which approach what must have been the initial pressures of the virgin territory (approximately 300 psi) have been observed in wells drilled during the 1940s in the northern part of the field. A well drilled in 1962 reported a rock pressure of 145 psi.

Operators in this field have long awaited a means of completing their wells so that oil could be produced in large enough quantities to provide a fair and prompt return on their investment. With the introduction of fracturing in the area this expectation has been realized. At the writing of this report 7 out of 9 wells have been fractured into commercial producers and 12 rigs are operating in the area.

OTHER HORIZONS

Gas and oil shows have rarely been encountered in the horizons above the Glade Sand. The shows that have been found were of no

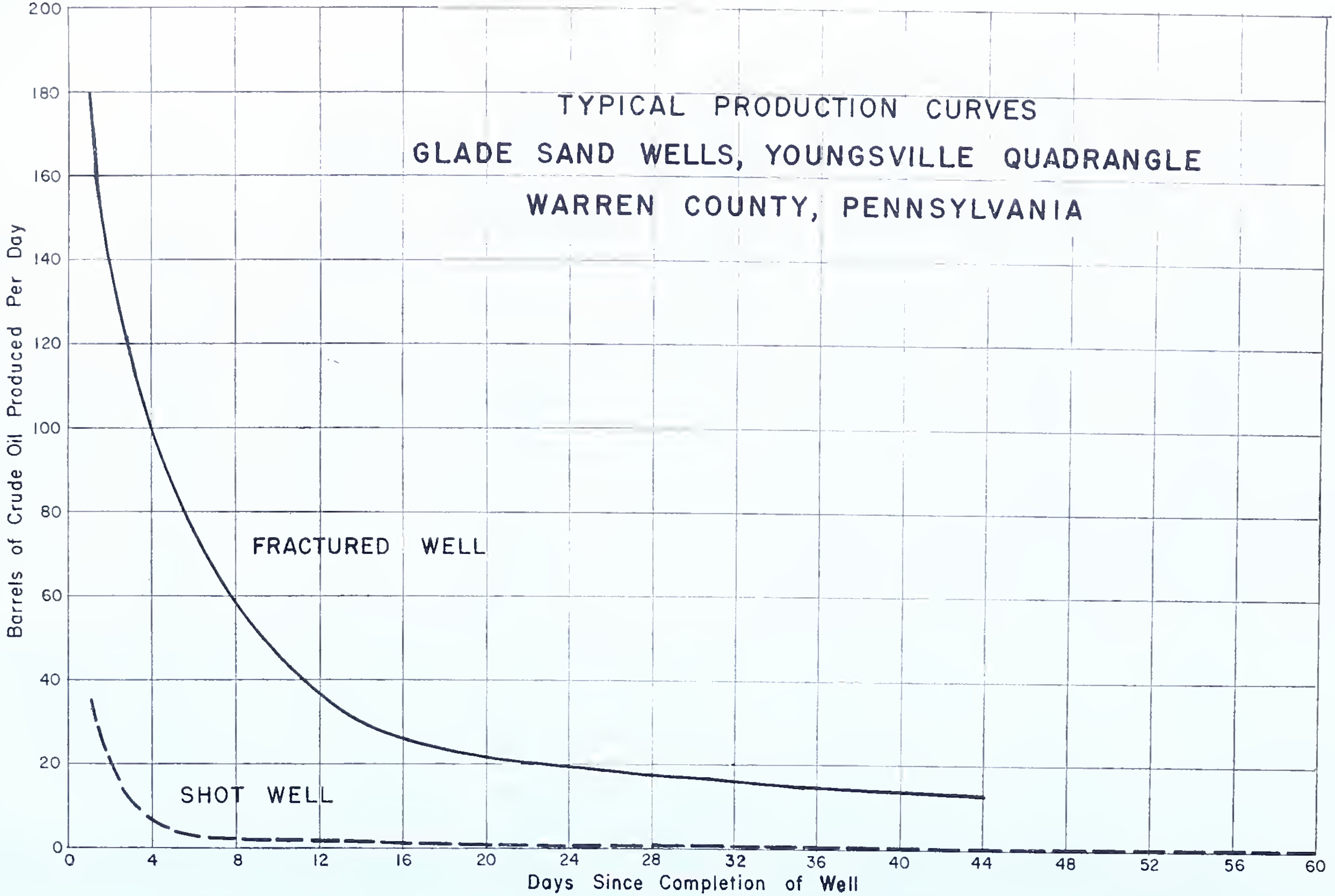
Table 2. *Records of Wells Drilled in the Youngsville-Sugar Grove Field during 1962**

Map No.	1	2	3	4	5	6	7
Well Name	Sandene 1	Sandene 18	Hamilton 10	Jones 8	Rowley 1	Lehmann 21	Sandene 19
Operator	Earl Linn	Howard Curtis	Austin Curtis	Cady-Denton	Wm. Eakas	Lehmann	Howard Curtis
Township	Sugar Grove	Sugar Grove	Sugar Grove	Sugar Grove	Sugar Grove	Farmington	Sugar Grove
Elevation	1450 Gr	1530	1490	1360	1650	1560	1470
Casing	6¼″-251′			6¼″-122′	6¼″-85′	6¼″-168′	6¼″-235′
Glade (top) Ft.	639	696	664	512	820	720	660
Glade (bott.) Ft.	677	736	700	557	860	747	702
FRACTURING INFORMATION	4½″-717′	4½″-766′	4½″-674′			4½″-765′	4½″-727′
Fracturing Interval	Perf. 665	Perf.	674-96			Per. 734-37	Perf.
MCA gals.	150		250				
Water bbls.	418	548	360	400		400	520
Sand 20/40 lb.	6000	?	18,000	20,000		28,000	27,000
Sand 10/20 lb.	13,000	?					
Breakdown Pres. psi	4750	3800	3100			3800	3800
Treating Press. psi	1275	1200	1800			1900	1500
Inj. Rate bbl/min	26	36	35			28	35
Oil (IP-AF) bbls.	104/18 hrs	185/24 hrs	20/day	3/day water 1/day oil	15/day Est.	35/day	180/24 hrs.
Gas (IP-AF) Mcf	50 est						
Total Depth Ft.	720	766	721	570	889	766	727
Completed	8/21/62	9/26/62	9/4/62	9/26/62	10/13/62	10/30/62	11/13/62

*Records from a report of the Petroleum Information Corporation.

Map No.	8	9	10	11	12	13	14
Well Name	Frank U. Tegg #1	Short 1	Cataldo 1-A	Crispin 1	Sanders 1	Langdon #1	Carlson #1
Operator	Earl Linn	Richardson Pet.	R. Cordner	A. E. Eakas	J. F. Flanigan	Lou Cotton	Keystar Pet.
Township	Sugar Grove	Sugar Grove	Sugar Grove	Sugar Grove	Sugar Grove	Brokenstraw	Sugar Grove
Elevation	1395 Gr	1370 Gr	1460 Df	1630 Gr	1440 Gr	1300 Gr	
Casing	6¼″-255′	6¼″-170′	6¼″-235′	6¼″-170′	4½″-647′	6¼″-275′	8″-21′
Glade (top) Ft.		542	620		598	867	846
Glade (bott.) Ft.		590	676				
FRACTURING INFORMATION	4½″-655′	4½″-657′	4½″-690′		4½″-647′		
Fracturing Interval	Perf. 618-19	Perf. 572-75	Perf. 670-72		Perf. 615-17		
MCA gals.	250		250				
Water bbls.	432	400	565		600		
Sand 20/40 lb.	10,000	28,000	13,000		3500		
Sand 10/20 lb.	20,000		13,000				
Breakdown Pres. psi	4700	2200	4800		4500		
Treating Pres. psi	1367				1200		
Inj. Rate bbl/min	29	40					
Oil (IP-AF) bbls.	40/day	5/hr	12/day				
Gas (IP-AF) Mcf	50		w/gas				
Total Depth ft.	655	657	690			927	910
Completed	Testing	Testing	11/20/62	Drilling	Testing	To frac.	Testing AF

Map No.	15	16	17	18	19	20
Well Name	Hale #1	Chase #1	Lehmann #22	Sanders #2	Sandene #20	Christy Nelson #1
Operator	Odell	Curtis-Stewart	C. E. Lehmann	Flanigan Dr.	Howard Curtis	Earl Linn
Township	Sugar Grove	Sugar Grove	Farmington	Sugar Grove	Sugar Grove	Sugar Grove
Elevation	1375 Gr	1560 Gr	1520 Gr	1470 Gr	1545 Gr	1850 Gr
Casing		7″-195′				7″-350′
Completed	Drilling	Drilling	Drilling	Driling	Drilling	Drilling



TYPICAL PRODUCTION CURVES
GLADE SAND WELLS, YOUNGSVILLE QUADRANGLE
WARREN COUNTY, PENNSYLVANIA

Figure 3

Table 3. *Records of Deep Wells Drilled in Youngsville-Sugar Grove Field*

Map No.	A	L	M
Well Name	Anderson #1	I. L. Anderson #1	Mrs. Carl Keester #1
Operator	Pettigrew, et al	Star Oil	Pa. Gas Co.
Township	Sugar Grove	Brokenstraw	Brokenstraw
Elevation	1360	1208	1262
Completed	5/23/47	1922	7/12/57
Tully	2842?-2859	—	3170-
Onondaga	3046-3183	3385-3510	3478-3596
Oriskany	horizon 3210?	3510-3520	3596-3599
Bass Island	3210?-3249	3520-3580E	3599-3664
Salina	3249-3820	3580E-4210	3664-4315
Guelph-Lockport	3820-4097	4210-4435	4315-4581
Clinton	4097-4228	4435-4545?	4581-4721
Grimsby	4228-	4537 DL 4545?-4650	4721?-4833
Whirlpool	4398-	-4745	4882 DL-4886 DL
Queenston	4413-	4745-	4886-
Total depth	-4435	-5035	-4898
Deepest Fm. reached	Queenston	Queenston	Queenston
Remarks	SW @ 3974, Dry	Show of gas saltwater in Onondaga Salt 3885-3910 SW 4380 E* Estimated DL-Drillers Log	Onondaga fraced & acidized no results salt 3978-4018 4216-4238 show of gas @4817-4829

consequence. The few wells drilled below the Glade Sand have only encountered "sand shells" at the Clarendon horizon. In the rest of the Upper Devonian section below the Clarendon horizon no well-developed sands have been found. Three wells in the area have been drilled below the Upper Devonian (Table 3). All three were dry and they all bottomed in the Queenston (Upper Ordovician).

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Carll, John F. (1883), *Geological Report on Warren County, Pa.*, Pa. Geol. Survey, 2nd Ser., Report I 4, p. 266.

Table 4. *Report of Crude Petroleum Analysis*
United States Bureau of Mines Sample 45013*

IDENTIFICATION

Five Points Pool
Glade Sand, Upper Devonian
700-746 feet

Sugar Grove Oil Co.
Well No. 8

Pennsylvania
Warren County, Sugar Grove Twp.
Youngsville quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.819
Sulfur, percent, 0.12
Saybolt Universal viscosity at 100° F., 42 sec.

A.P.I. gravity, 41.3
Color, NPA No. 7

DISTILLATION, BUREAU OF MINES HEMPEL METHOD

STAGE 1—Distillation at atmospheric pressure, 749 mm
First drop, 30° C. (86° F.)

Fraction No.	Cut. ° C	at ° F	Per-cent	Sum Percent	Specific Gravity 60/60° F	API 60° F	C.I.	S.U, Visc. 100° F	Cloud Test ° F
1	50	122	1.3	1.3					
2	75	167	2.1	3.4	0.654	84.9			
3	100	212	5.8	9.2	0.711	67.5	17		
4	125	257	7.0	16.2	0.736	60.5	20		
5	150	302	6.1	22.3	0.754	56.2	21		
6	175	347	5.3	27.6	0.769	52.5	21		
7	200	392	5.6	33.2	0.780	49.9	20		
8	225	437	5.5	38.7	0.791	47.4	20		
9	250	482	5.1	43.8	0.805	44.5	21		
10	275	527	6.8	50.6	0.816	41.9	22		
STAGE 2—Distillation continued at 40 mm.									
11	200	392	3.7	54.3	0.834	38.2	26	40	20
12	225	437	6.3	60.6	0.843	36.4	27	45	40
13	250	482	5.2	65.8	0.857	33.5	30	55	55
14	275	527	5.3	71.1	0.865	32.1	31	74	70
15	300	572	5.6	76.7	0.870	31.1	30	140	85
Residuum			23.2	99.9	0.902	25.4			

Carbon residue of residuum, 1.9 percent; carbon residue of crude 0.4%

APPROXIMATE SUMMARY

	Percent	Specific Gravity	API	Viscosity
Light Gasoline	9.2	0.690	73.6	
Total gasoline & naphtha	33.2	0.739	60.0	
Kerosine distillate	17.4	.805	44.5	
Gas oil	9.8	.841	36.8	
Nonvisc. lubricat'g distillate	10.2	.850- .867	35.0-31.7	
Medium lubricat'g distillate	6.1	.867- .872	31.7-30.8	60-100
Viscose lubricat'g distillate	—	—	—	100-200
Residuum	23.2	.902	25.4	above 200
Distillation loss	0.1			

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